

**REMARKS**

Entry of the foregoing amendments is respectfully requested.

**Summary of Amendments**

Upon entry of the present amendments, claims 75, 88, 108 and 123 are amended, whereby claims 70-99, 101-117 and 119-139 will remain pending. Claims 70, 84, 101, 119, 132 and 135 are independent claims.

Claims 75, 88, 108 and 123 have been amended by deleting the compound  $(\text{CH}_3)_3\text{NBH}_3$  therefrom.

Applicants emphasize that the amendments to claims 75, 88, 108 and 123 are without prejudice or disclaimer, and Applicants expressly reserve the right to prosecute the amended claims in their original, unamended form in one or more divisional and/or continuation applications.

Applicants point out that entry of the present amendments is proper because they do not raise new issues and do not require further consideration and/or search. On the contrary, they reduce the number of issues for appeal.

**Summary of Office Action**

As an initial matter, Applicants note that claims 98, 117 and 131 are allowed (although Applicants note that these claims depend from rejected base claims). Applicants further note with appreciation that all claims objections under 37 CFR 1.75(i)

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and the claim rejections under 35 U.S.C. § 112, second paragraph, have been withdrawn.

Claims 75, 88-90, 108, 109 and 123 remain rejected under 35 U.S.C. § 112, first paragraph, as allegedly failing to comply with the written description requirement.

Claims 70-83 and 132-134 are rejected under 35 U.S.C. § 102(b) as allegedly being anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as allegedly being obvious over Finkelshtain et al., US 2002/0083640 A1 (hereafter "FINKELSHTAIN") alone or in view of Amendola et al., US 2002/0083643 A1 (hereafter "AMENDOLA") and further in view of the evidentiary document Pecsok, R.L., "Polarographic Studies on the Oxidation and Hydrolysis of Sodium Borohydride," J. Am. Chem. Soc., (75), 1953, pp. 2862-4 (hereafter "PECSOK").

Claims 84-97, 99-116, 118-130 and 135-138 are rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over FINKELSHTAIN alone or in view of AMENDOLA and further in view of PECSOK.

Claims 70-83 and 132-134 are rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Suda, US 2002/0015869 A1 (hereafter "SUDA") alone or in view of AMENDOLA.

Claims 70-83 and 132-134 are rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as allegedly being obvious over Tsang, U.S. Patent No. 6,818,334 B2 (hereafter "TSANG I") alone or in view of AMENDOLA.

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Claims 84-97, 99-116, 118-130 and 135-138 are rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over TSANG I or Tsang, EP 1369947 A2 (hereafter "TSANG II"), alone or in view of AMENDOLA.

Claims 70-83 and 132-134 are rejected under 35 U.S.C. § 102(a) as allegedly being anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as allegedly being obvious over TSANG II alone or in view of AMENDOLA.

### **Response to Office Action**

Reconsideration and withdrawal of the rejections of record are respectfully requested in view of the foregoing amendments and the following remarks.

### ***Response to Rejection of Claims 75, 88-90, 108, 109 and 123 under 35 U.S.C. § 112, First Paragraph***

Claims 75, 88-90, 108, 109 and 123 are rejected under 35 U.S.C. § 112, first paragraph, as allegedly failing to comply with the written description requirement. Specifically, the rejection essentially asserts that the recited compound " $(\text{CH}_3)_3\text{NBH}_3$ " does not appear to have basis in the originally filed specification, including the claims.

Applicants submit that the compound  $(\text{CH}_3)_3\text{NBH}_3$  has been deleted from claims 75, 88, 108 and 123, thereby rendering this rejection moot. Applicants emphasize that the deletion of the compound  $(\text{CH}_3)_3\text{NBH}_3$  is by no means to be construed as Applicants' admission that the rejection is meritorious but merely is to expedite the

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issuance of a patent with the claims submitted herewith or to reduce the number of issues for appeal, respectively.

***Response to Modified Rejections under 35 U.S.C. §§ 102(b)/103(a)***

The present Office Action essentially repeats the rejections under 35 U.S.C. §§ 102(b)/103(a) already set forth in the previous Office Action, with some of these rejections being supplemented/modified by two new arguments.

Specifically, the rejections based on FINKELSHTAIN as the primary document now also rely on a newly cited document, i.e., PECSOK, which allegedly discloses “that the stability of the aqueous sodium borohydride solution increases with increasing pH (as effected by employing greater amounts of sodium hydroxide)”. The rejections based on TSANG I/TSANG II as the primary document now also make reference to paragraph [0032] of AMENDOLA.

In this regard, Applicants note that the results described by PECSOK were obtained in a weakly alkaline pH range. For example, Fig. 1 at page 2863 of PECSOK is a graphic representation of the results obtained for the decomposition of sodium borohydride as a function of time and pH. As can be taken from the legend of Fig. 1 of PECSOK the experiments were carried out in the pH range from 7.7 (curve A) to 9.5 (curve E). Already at pH 9.5 (curve E) the decomposition of sodium borohydride appears to be very slow.

Further, in the last paragraph of the left column of page 2862 of PECSOK it is mentioned that sodium borohydride solutions stored at pH 12 (0.01 M sodium

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hydroxide) decomposed only a few tenths of a percent per day. In view thereof, it would have been readily apparent to one of ordinary skill in the art that there is no reason to worry about any significant decomposition of the borohydride in the compositions of FINKELSHTAIN with a KOH concentration of 6 M (pH 14), i.e., 600 times the hydroxide ion concentration for which PECSOK reports a very slow decomposition of borohydride solutions. Accordingly, even a combination of the teachings of FINKELSHTAIN, AMENDOLA and PECSOK is unable to render obvious, let alone anticipate, the subject matter of any of the claims of record.

With respect to the rejections based on TSANG I/TSANG II in view of AMENDOLA, the rejections now also allege that AMENDOLA “suggests starting with a concentrated solution and adding water during use ([0032] at the last 2-4 lines of page 2)”. See pages 15 and 16, first paragraphs, of the present Office Action.

In this regard, it is pointed out that one of the things that AMENDOLA has in common with TSANG I/TSANG II is that these documents relate to the use of a borohydride solution as a hydrogen source for a fuel cell which uses hydrogen as fuel, i.e., not a liquid fuel cell which (directly) uses a borohydride solution as fuel (without separate generation of hydrogen gas). As already set forth in the responses to the previous Office Actions, the borohydride solutions of TSANG I/TSANG II are not used as such to operate a direct liquid fuel cell, but only indirectly in that after addition thereto of a (metal) catalyst which catalyzes the decomposition reaction of the borohydride according to the equation shown in, e.g., col. 2, line 58 of TSANG I to generate

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hydrogen gas, the hydrogen gas is transferred to a fuel cell which uses the hydrogen as fuel.

The same applies to AMENDOLA. According to its abstract, AMENDOLA relates to the use of borohydride based solutions as a hydrogen storage source and a catalyst system to release hydrogen therefrom. An equation similar to that in col. 2 of TSANG I is shown in paragraph [0028] of AMENDOLA.

Further, the complete paragraph [0032] of AMENDOLA on which the Examiner now relies states (emphases added):

Since two water molecules are consumed for each borohydride molecule according to reaction (1), the concentration of all the remaining components (the cation, the borate, and the borohydride) will increase as the reaction continues. Therefore, twice as many water molecules as borohydride molecules are needed to sustain a constant rate of reaction. This excess water can be provided to the reaction in two ways: (i) charging the initial metal hydride solution with excess water, i.e., starting with a dilute solution, or (ii) adding more water from a separate source during or after the reaction. The second alternative is preferred to minimize the initial starting weight of water plus borohydride. Adding water from a separate source during or after the reaction is viable because the main byproduct of hydrogen oxidation in a hydrogen-consuming device is water. A hydrogen-consuming device, as used herein, means a device that uses hydrogen as a fuel, e.g., a fuel cell, combustion engine, or a gas turbine. Thus, water generated from the hydrogen-consuming device can be added to the borohydride solution. Assuming that water is recycled from the fuel cell or engine, 8 weight units of hydrogen (4 from water and 4 from borohydride) can come from 22 weight units of lithium borohydride. The resulting theoretical hydrogen conversion ratio is 36.36% by weight of hydrogen per unit of borohydride (8.div.22.times.100). Therefore, the hydrogen generation system can include a slurry tank to store the borohydride and an adjacent mixing tank to add additional water obtained from the exhaust of the hydrogen consuming device, thereby allowing complete reaction of the borohydride while preventing the borohydride solution from drying out, i.e., preventing the components of the borohydride solution from precipitating out of solution.

Particularly the above underlined passages of paragraph [0032] of AMENDOLA make it clear that AMENDOLA neither teaches nor suggests providing a borohydride containing concentrate and diluting the concentrate with a polar solvent to prepare the final fuel for a (direct liquid) fuel cell, let alone providing a packaged combination of the concentrate and the solvent. In fact, according to AMENDOLA the solvent (water) for the dilution of the water-depleted borohydride solution is not even present at the beginning, but is continuously generated by the oxidation of the hydrogen gas inside, e.g., a fuel cell and is then recycled to the borohydride solution from which a part of the hydrogen of the water originated (the other part originates from the borohydride).

***Response to Examiner's "Response to Arguments"***

At the bottom of page 17 of the present Office Action it is alleged that claims 132-134 are not encompassed by Applicants' arguments at pages 24-5 of the response to the previous Office Action in that these claims are not limited to any molarity.

Applicants respectfully submit that Applicants' corresponding arguments were directed to the fact that the preferred KOH molarity of the borohydride compositions of FINKELSHTAIN, i.e., 6M, would be considered by one of ordinary skill in the art to be high enough to provide a highly alkaline environment and to thereby not give rise to any concerns regarding the stability of the borohydride. For this reason alone, there is no motivation provided for one of ordinary skill in the art to prepare a concentrate with an even higher KOH concentration and then to dilute this concentrate for use in a liquid fuel cell. Independent claim 132 is drawn to exactly that, i.e., a method of reducing the

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decomposition of a fuel for a direct liquid fuel cell during storage of the fuel, wherein the method comprises storing the fuel as a concentrate and diluting the concentrate to prepare the fuel only before using the fuel in the fuel cell.

The remarks in the sentence bridging pages 17 and 18 of the present Office Action are not completely understood, wherefore Applicants are unable to comment thereon in detail. It is noted, however, that even if one were to assume, *arguendo*, that “the relationship between increased basicity and storage stability is well known” it would immediately be apparent to one of ordinary skill in the art that even if a significant amount of KOH were added to an aqueous 6M KOH solution, the pH thereof would not (significantly) increase because a pH of 14 usually (i.e., except for extremely highly concentrated solutions) is the upper limit of the pH range (due to the dissociation constant of water of about  $10^{-14}$  M). In other words, while the addition of KOH to a 6M KOH solution will increase the concentration of KOH in the solution, it is to be expected that this addition will not further increase the concentration of dissociated KOH, i.e., the concentration of OH<sup>-</sup> ions (whose concentration determines the basicity, i.e., the pH, of the solution).

In the last sentence of the first paragraph of page 18 of the present Office Action it is alleged that “Applicant did not address the rejection based on the combination of ‘640 [FINKELSHTAIN] in view of ‘643 [AMENDOLA] (paragraph bridging pages 13-4 of the Office action). In this regard, it is respectfully submitted that the rejection of claims 70-83 and 132-134 under 35 U.S.C. § 103(a) as allegedly being obvious over FINKELSHTAIN in view of AMENDOLA is without merit for the same reasons as the



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rejection of claims 84-97, 99-116, 118-130 and 135-138 under 35 U.S.C. § 103(a) over the same documents. In particular, as stated at page 27, second paragraph of the Amendment filed September 29, 2006, AMENDOLA does not add anything to the disclosure of FINKELSHTAIN in that the most preferred pH according to AMENDOLA (greater than about 14) is already embodied in the 6M KOH fuel of FINKELSHTAIN.

In the first paragraph of page 19 of the present Office Action it is alleged that “869 [SUDA] does provide a motivation to prepare a range of mixtures in order to obtain the desired power generating capacity. Further, ‘643 [AMENDOLA] suggests starting with a concentrated solution and adding water during use ([0032] at the last 2-4 lines of page 2). The motivation to dilute such mixtures in order to match needs with resources on hand is found in the long existing practice of creating concentrates for storage and transport and performing dilution at the use site”.

In response, Applicants note that the complete passage of SUDA which the Examiner relies on in the rejection of process claims 70-83 and 132-134 reads as follows (emphases added):

**[0048]** The electrolyte solution in the inventive liquid fuel cell, which serves also as a hydrogenion source, is an aqueous solution prepared by dissolving the above mentioned metal-hydrogen complex compound in an aqueous alkaline solution which can optionally be admixed with a water-miscible organic solvent such as a lower alcohol solvent. The alkaline compound used for making up the above mentioned aqueous alkaline solution is selected from alkali metal hydroxides such as lithium hydroxide, sodium hydroxide and potassium hydroxide and quaternary ammonium hydroxides such as tetramethylammonium hydroxide and tetraethylammonium hydroxide.

**[0049]** The aqueous alkaline solution contains the above-mentioned alkaline compound in a concentration of at least 5% by weight or, preferably, at least 10% by weight. Although the concentration of the alkaline compound has no definite upper limit up to the saturation concentration, the concentration should practically

not exceed 30% by weight because of the limited solubility behavior of the metal-hydrogen complex compound in the aqueous alkaline solution when the alkali concentration is excessively high.

[0050] The concentration of the metal-hydrogen complex compound dissolved in the aqueous alkaline solution is selected usually in the range from 0.1 to 50% by weight in consideration of the desired power generating capacity of the liquid fuel cell and the solubility behavior of the complex compound in the aqueous alkaline solution. When improvement is desired in the ionic conductivity of the aqueous alkaline solution of which the alkaline compound is not lithium hydroxide, it is optional that the solution is admixed with a small amount or, for example, 0.01 to 0.1% by weight of lithium hydroxide.

The above passage contains no suggestion whatsoever to prepare a concentrate and to then dilute the concentrate. A fair reading of this passage (i.e., without applying hindsight) reveals that this passage merely provides information as to the preferred (recommended) concentration ranges for the individual components of the electrolyte solution. For example, in addition to a suitable concentration range for the metal-hydrogen complex, suitable concentration ranges for the alkaline compound and for lithium hydroxide are given as well in this passage. This corresponds to common practice in the patent literature and would not be considered to be an invitation to provide a concentrate for dilution purposes.

Applicants point out that SUDA warns that too high a concentration of the alkaline compound may cause problems with respect to the solubility of the metal-hydrogen complex. This would appear to provide a disincentive for one of ordinary skill in the art to significantly increase the KOH concentration of the 6M KOH of FINKELSHTAIN and thus, is yet another reason why this document alone or in view of AMENDOLA does not render obvious any of the claimed subject matter.

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Further, with respect to AMENDOLA, it has already been explained above why [0032] at the last 2-4 lines of page 2 of this document alone provides a skewed representation of the entire disclosure of paragraph [0032] and the disclosure of AMENDOLA in general.

Even further, it is noted that present independent claim 132 is drawn to a method of reducing the decomposition of a fuel for a direct liquid fuel cell during storage of the fuel. Neither SUDA nor AMENDOLA are directed to corresponding subject matter, which is yet another reason why these documents are unable to render obvious the subject matter of present claims 132 and the claims dependent therefrom.

At the bottom of page 19 of the present Office Action (and in subsequent passages thereof as well) it is alleged that "Applicant fails to assert that the disclosed methods of '334 [TSANG I] produce fuels that are unsuitable for direct liquid fuel cell. Applicant's claims are to processes of storing concentrate and diluent and then mixing, and contain statements of intended use, but do not include actually directing the so made fuel to a direct liquid fuel cell. Applicant's assessment of the state of the prior art (specification, second sentence in [0003]) is considered germane; the fuels for the generation of hydrogen are substantially the same as the fuels for direct liquid fuel cells."

In this regard, Applicants note that the indication of the intended use of the fuel concentrate recited in the independent method claims 70 and 132, i.e., for preparing a fuel for a direct liquid fuel cell, implies certain characteristics of the fuel and the fuel concentrate, respectively which are not necessarily present in a fuel (concentrate) which

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is merely used for the generation of hydrogen. For example, it is apparent that a fuel that is to be used directly (as such) in a fuel cell (i.e., without generating hydrogen therefrom first) must not contain impurities which would cause significant harm to the (interior of the) fuel cell and/or the feeding device for the fuel possibly associated therewith (e.g., corrosion) and/or would poison the oxidation catalyst of the anode of the liquid fuel cell (which catalyst is to catalyze, e.g., the reaction depicted in paragraph [0004] of the present specification and is to prevent, e.g., the reaction depicted in paragraph [0005] of the present specification (generation of hydrogen gas) to as high a degree as possible).

In contrast, a fuel that is used merely for the generation of hydrogen by catalytic decomposition of a metal hydride may contain impurities which would not usually be acceptable if the fuel were to be used directly inside the fuel cell (because essentially only the hydrogen gas will eventually reach the inside of the fuel cell).

Also, a fuel for use as a hydrogen generator may often have a much higher concentration of the components thereof than a fuel that is to be supplied directly to a fuel cell and must be used therein as such. In other words, a high viscosity of the fuel is much more acceptable when the fuel is to be used for the generation of hydrogen gas instead of as the actual fuel that is to be oxidized at the anode of the fuel cell.

Further, it is pointed out again that present independent claim 132 is drawn to a method of reducing the decomposition of a fuel for a direct liquid fuel cell during storage of the fuel. Neither TSANG I nor AMENDOLA are directed to corresponding subject

matter, which is yet another reason why these documents are unable to render obvious the subject matter of present claims 132 and the claims dependent therefrom.

With respect to the remarks in the passage starting at page 20, line 5 from the bottom of the present Office Action, Applicants respectfully submit that one of the main issues with respect to TSANG I/TSANG II is whether one of ordinary skill in the art would be motivated to (pre)package Solution A and Solution B described therein in the way recited in present independent claims 84, 101, 119 and 135. In this regard, it is noted that in the passage from col. 4, line 35 to col. 5, line 11, TSANG I states (emphases added):

The best mode to practice the embodiments disclosed herein is to meter the NaBH<sub>4</sub> solution (Solution A) and the second aqueous solution (Solution B) independently by two separate mechanical devices, i.e., pumps, into a chamber that contains the catalyst. ... To further accelerate the reaction rate, the reaction chamber may also be heated externally by a capacitor or other electronic device.

FIG. 1 depicts schematically a PEM fuel cell 10 employing the teachings herein. ...

Oxygen and/or air is introduced to the cathode 12, while hydrogen gas is introduced to the anode 14. Hydrogen gas is generated in a reaction chamber 20, using a catalyst (not shown). In the reaction chamber, aqueous sodium borohydride, exposed to the catalyst, generates hydrogen gas and sodium borate, as described above. Hydrogen from the reaction chamber 20 is then introduced into the PEM fuel cell 10.

In accordance with the teachings herein, Solution A, comprising sodium borohydride in water, and Solution B, comprising water, and the optional water-soluble additive, are combined in the reaction chamber 20. Solution A is contained in reservoir 22, while Solution B is contained in reservoir 24. A metering pump/valve 26 meters out the desired volume of Solution A into the reaction chamber 20, while metering pump/valve 28 meters out the desired volume of Solution B into the reaction chamber. Thus, Solutions A and B are metered separately from separate reservoirs 22, 24 and mixed within the reaction chamber 20.

In another embodiment, the reaction chamber is heated, using an external heating mechanism 30, to increase the reaction rate of the Solutions A and B in

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the presence of the catalyst. The temperature to which the reaction chamber is heated is advantageously less than the boiling points of the two solutions.

Clearly, the above statements refer to an operation on an industrial scale where the use of containers like those recited in the rejected claims would not make sense already for the reason that due to the large volumes of solutions A and B involved, corresponding (prepackaged) containers would have to be large and thus, difficult and burdensome to transport.

Further, if one were to assume that the process described in TSANG I is operated on a scale which would make the use of (prepackaged) containers like those recited in the rejected claims feasible, it is not seen that this would be an economical process. The containers and thus, the amount of hydrogen that can be generated from the contents of these containers would be much too small and would not be suitable for even the batchwise operation of complex equipment that apparently is needed to transfer the generated hydrogen (i.e., a highly flammable gas) from the reaction chamber to the fuel cell.

### **CONCLUSION**

In view of the foregoing, it is again submitted that all of the claims in this application are in condition for allowance, which action is respectfully requested. If any issues yet remain which can be resolved by a telephone conference, the Examiner is respectfully invited to contact the undersigned at the telephone number listed below.

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Respectfully submitted,  
Gennadi FINKELSHTAIN et al.



Neil F. Greenblum  
Reg. No. 28,394

November 27, 2006  
GREENBLUM & BERNSTEIN, P.L.C.  
1950 Roland Clarke Place  
Reston, VA 20191  
(703) 716-1191

Heribert F. Muensterer  
Reg. No. 50,417